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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/566,073

Applicant(s)

STRANO ET AL.

Examiner

JUN LI

Art Unit

4181

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☐ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) 13-24 is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/55/02)
Paper No(s)/Mail Date 12/27/2007, 02/04/2008
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date ____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: ____

DETAILED ACTION

Election/Restrictions

1. Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claim(s) 1-12, drawn to a method of functionalizing carbon nanotubes.

Group I, claim(s) 13-19, drawn to a method of separating carbon nanotubes.

Group III, claim(s) 20-23, drawn to a composition of the functionalized nanotubes.

2. The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature which is referred to Annex B of Appendix A1 of the MPEP (Administrative Instructions under the PCT, "Unity of Invention"). The express "special technical features" is defined as meaning those technical features that define a contribution which each of the inventions, considered as a whole, makes over the prior art."(Rule 13.2). Unity exists only when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding claimed special technical features. In this case, the technical feature shared by each invention is the **carbon nanotubes**.

The question of unity of invention has been reconsidered retroactively by the examiner in view of the search performed; a review of **Bahr et al (J. Am. Chem. Soc 2001, 123, 6536-6542), Tour et al (WO 02/060812) and in view of Krupke et al (Science 2003, 301, 344-347)**, makes clear that the inventions of the groups I-III lack the same or corresponding special technical feature because the cited reference(s) appear to demonstrate that the claimed technical feature does not define a contribution which each of the inventions, considered as a whole, makes over the prior art. Accordingly, the prior art of the record supports restriction of the claimed subject matter in to the groups as mentioned immediately above.

3. During a telephone conversation with Tom Thresh on September 16th a provisional election was made to prosecute the invention of group I, claim1-12. Affirmation of this election must be made by applicant in replying to this Office action. Claim13-23 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

4. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

5. The examiner has required restriction between product and process claims. Where applicant elects claims directed to the product, and the product claims are subsequently found allowable, withdrawn process claims that depend from or otherwise

require all the limitations of the allowable product claim will be considered for rejoinder. All claims directed to a nonelected process invention must require all the limitations of an allowable product claim for that process invention to be rejoined.

Rejoining Practice

In the event of rejoinder, the requirement for restriction between the product claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product are found allowable, an otherwise proper restriction requirement between product claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product claim will not be rejoined. See MPEP § 821.04(b). Additionally, in order to retain the right to rejoinder in accordance with the above policy, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product claims. **Failure to do so may result in a loss of the right to rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

Status of Application

The claims 1-23 are pending and the elected claim 1-12 are presented for the examination. Affirmation of this election must be made by applicant in replying to this Office action. Claim 13-23 are withdrawn from further consideration

Drawings

6. The drawings are objected to because the molecular name on the structure of the diazonium salt is unclear. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

7. Claims 7-11 are objected to under 37 CFR 1.75(c) as being in improper form because a multiple dependent claim of claim 2-5. Claim 12 are objected to under 37 CFR 1.75(c) as being in improper form because a multiple dependent claim of claim 1-10. See MPEP § 608.01(n). Appropriate corrections needed.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 1 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 1, the phrase "preferentially with" renders the claim(s) indefinite because the claim(s) include(s) elements not actually disclosed (those encompassed by "or the like"), thereby rendering the scope of the claim(s) unascertainable. See MPEP § 2173.05(d).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical

Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

8. Claims 1, 2, 4, 5, 8, 10, 12 are rejected under 35 U.S.C. 102(b) as being unpatentable by Bahr et al (J. Am. Chem. Soc 2001, 123, 6536-6542).

Regarding to claim 1-2, Bahr et al (J. Am. Chem. Soc 2001, 123, 6536-6542) teach a functionalization of carbon nanotubes with diazonium salts (Title, page 6535, and Fig 1). Functionalization of Carbon nanotubes (single wall nanotubes samples, SWNT-p)(page 6537, results line 1-2) are carried out via electrochemical reaction (page 6541, last paragraph line 1-2) in solution (First paragraph, lines 6, 12) (Results First paragraph line 14-21, page 6537). Bahr et al further teach that small-diameter carbon nanotubes display enhanced reactivity over larger-diameter tubes (line 3-7, page 6537 first paragraph) and that electronic properties of the carbon nanotubes has been utilized because of the different tube diameters and chiral indices (Results second paragraph, line 4-9, page 6537, Fig 3 and second paragraph lines 5-11, lines 15-20, table 1, page 6538). Resulted stoichiometries of the functional species (diazonium salt, fig 2) and the carbon atoms in the nanotubes are estimated (line 5-9, second paragraph, page 6539). Bahr et al further teach that some tube diameters provide a greater degree of functionalization for that particular-diameter nanotubes(line 10-12, third paragraph, page 6541).

Regarding to claim 4-5, Bahr et al teach the carbon nanotubes for

functionalization are single wall nanotubes samples (SWNT-p)(page 6537, results line 1-2).

Regarding to claim 7-8, Bahr teach different types of aryl diazonium salt (Fig 2, page 6537).

Regarding to claim 10 Bahr teach diazonium compound are prepared from the reaction of corresponding aniline derivatives and nitrosonium tetrafluoroborate, (page 6537 line10-13, Figure 2 and Scheme 1).

Regarding to claim 12, Bahr et al also anticipate thermal removal functionalized moiety (second paragraph, line 1-8, fig 8, 9, page 6539).

9. Claims 1, 2, 4, 5, 7, 8, 10, 12 are rejected under 35 U.S.C. 102(e) as being anticipated by Tour et al (WO 02/060812).

Regarding to claim 1,2,4,5,Tour et al teach a process for modifying carbon nanotubes (including multi and single-wall carbon nanotubes) by reacting the nanotubes with a diazonium species (Abstract line 1-7, page 10, line 8, 15, 26-29, claim 1-10,13).

Regarding to claims 7 and 8, the structure is anticipated in Tour et al Fig 1 (page 4, line 8-11).

Regarding to claim 10, diazonium species is generated in situ (abstract line 15-16, page 4, line 10-11 and Fig 2) and substituted aniline species has a general formula as stated in the instant claim.

Regarding to claim 12, Tour et al expressly teach functionalized carbon nanotubes can be defunctionalized via heat (claim 28-30).

The applied reference has a common inventor James Tour with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

10. Claims 3, 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al (J. Am. Chem. Soc 2001, 123, 6536-6542) in view of Krupke et al(Science 2003, 301, 344-347).

The teaching of Bahr et al has already been described as above.

Bahr do not expressly teach an aqueous surfactant solution.

Krupke et al anticipate single wall nanotubes generally grown together as bundles in suspension because of van der Waals interactions (page 344, left column, line 8-11). Krupke et al further teach that a stable solution with high yields of individual SWNTs (line 11-16, left column, page 344) can be obtained by homogenizing a suspension of SWNT's in water in presence of a surfactant (here sodium dodecyl sulfate (SDS), page 344, left column, second paragraph line 4-6).

Therefore, it would have been obvious at the time of the invention filed for one skilled in the art to incorporate this teaching to practice the selectively functionalizing carbon nanotubes to obtain a stable individual SWNTs suspension.

11. Claims 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al (J. Am. Chem. Soc 2001, 123, 6536-6542) in view of Belmont et al (US 5851280) .

Bahr et al anticipate a variety of diazonium compound prepared from the corresponding aniline derivatives reacting with nitrosonium tetrafluoroborate (page 6537 line 10-13, Figure 2 and Scheme 1). Bahr et al do not expressly teach using an alkyl nitrite to generate diazonium compound. Both nitrosonium tetrafluoroborate and alkyl nitrite has same functional nitrosol group for the diazotization reaction. It is commonly known in

the art that substitutions of different functional group can be present for the diazotization reaction (Sci-Tech Dictionary. McGraw-Hill Dictionary of Scientific and Technical Terms. 2003).

Belmont et al (US 5851280) teach diazonium salt via a variety of ways (column 3 lines 47-48, lines 65-column 4 lines 6, column 4 lines 6-10). Belmont et al (US 5851280) further teach that in situ generation of unstable diazonium salt can avoid unnecessary handling and manipulation (column 3 lines 59-61).

Therefore it would have been obvious for one skill in the ordinary art to substitute nitrosonium tetrafluoroborate with an alkyl nitrite to produce diazonium compound because different functional groups can provide similar diazotization reaction for in situ diazonium salt generation and yield similar diazonium salt for future application. One would have been motivated to do so because alkyl nitrite is a functional equivalent of the nitrosonium tetrafluoroborate as indicated in the definition of diazotization reaction of Sci-Tech Dictionary and generate unstable alkyl diazonium salt to avoid unnecessary handling or manipulation before later on application as indicated in Belmont et al (US 5851280, column 3 lines 59-61).

12. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bahr et al (J. Am. Chem. Soc 2001, 123: 6536-6542) in view of Tsuchida et al (Die Makromolekulare Chemie 1970, 132:209-213) and Dunn (US 4264529).

The teaching of Bahr et al has already been described as above. They anticipate a variety of functional group can be used as the R group in the diazonium compound (page 6537 line10-13, Figure 2 and Scheme 1).

Bahr et al does not expressly disclose the functional group is a hydroxyl group OH.

Tsuchida et al (Die Makromolekulare Chemie 1970, 132:209-213) teach an aniline compound ("p-aminophenol", page 209, summary line 1) with an OH functional group. Tsuchida et al further teach that this chemical derived compound has reversible oxidation and reduction properties because of the presence of both hydroxyl and amine group at this compound (page 209 summary line 6).

Dunn (US 4264529) teach that p-aminophenol derivatives having a wide variety of industrial application (column 1 lines 4-9).

Therefore, it would have been obvious at the time of the invention filed for one ordinary skill in the art to adopt a hydroxyl group on the aniline species during diazonium salt generation for later on functional modification of nanotubes. One would have been motivated to do so because the polar functional hydroxyl moiety can be attached to the carbon nanotubes for further modification for intended uses as p-aminophenol intermediates as indicated in Dunn et al (column 1 lines 4-9).

Conclusion

1. No claim is allowed.
2. All pending claims are subject to rejections.
3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Jun Li whose telephone number is 571-270-5858. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vickie Kim can be reached on 571-272-0579. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Jun Li

September 17, 2008

Art unit 4181

/Vickie Kim/

Supervisory Patent Examiner, Art Unit 4181